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ABSTRACT

This report on an investigation of available hardware which would support music peripherals in an instructional mode focuses on the application of microcomputers to the teaching of music. It discusses microprocessor-based PLATO instruction, hardware selection, and courseware transfer, and notes that experimental lesson results indicate that microcomputers have the demonstrated capacity to support high-quality computer-based education in music. References are provided. (FM)

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COURSEWARE DEVELOPMENT FOR MICRO-PROCESSOR BASED INSTRUCTION IN MUSIC

by

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COURSEWARE DEVELOPMENT FOR MICRO-PROCESSOR BASED INSTRUCTION IN MUSIC

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In continuing the search for less expensive computer hardware capable of delivering high-quality instruction in music, innovative applications of "stand-alone" microprocessors (computers) have been conducted at the University of Illinois. In a paper by Peters (1976), the importance of a viable operating system was outlined for a small (micro) computer system, as well as a very large system, each with music peripherals. An expansion of the micro-computer concept was presented in an ensuing paper by Peters (1979).

To date, most successful computer-based education (CBE) applications in music have been conducted on large to mid-sized computers with all the advantages and disadvantages linked to the large computer concept. The development of a stand-alone system for teaching music is timely, in that the marketplace now offers numerous types of computer devices from which to select and choose to design an operating "system". Although many components of the system have been available previously, the synthesis of hardware and software into an operating system is viewed as a major step toward making CBE a more economic avenue to learning.

When first conceived, the idea of using smaller computers for music instruction yields obvious economic advantages. In light of the desired operation of hardware for music instruction, many small computers and even mini-computers have not been able to process the required instruction set. Using a pre-determined list of criteria, the investigation of available hardware was limited to recently developed microprocessors that could support music peripherals in an instructional mode.

MICROPROCESSOR BASED PLATO INSTRUCTION

The initial research project into courseware development for microprocessors was to investigate the feasibility of the application of microprocessor technology to computer-based education in music. Two questions were considered in this investigation:

What hardware is available to develop a viable microcomputer system capable of:

a) supporting music peripherals
b) displaying requisite music notation and graphics
c) maintaining and delivering instructional materials

What useable computer language should be used to operate selected hardware that is:

a) commonly in wide use by micro-computer programmers
b) capable of supporting graphic displays and music notation
c) capable of operating music peripheral devices as part of the instructional system

Using the Peters "complete-music-system" concept as a blueprint, an investigation was conducted to determine if technology had advanced to the point in 1978 where equipment capable of supporting music instruction could be purchased with little developmental difficulty.

The stand-alone music system was to include a four-voice tone generator, a tape playback system, touch input, graphics display, slides, (optional).. The added requirements of analog-to-digital input and a music keyboard were also considered desirable optional equipment for the microprocessor music system.

HARDWARE SELECTION

The hardware selected for the first microprocessor development project at Illinois was the PLATO V computer terminal. The development of this terminal by Stifle (1977) combined the microprocessor capabilities with those of the graphics PLATO IV terminal. Gooch (1978) noted the "8080 microprocessor system in the PLATO V terminal is capable of executing programs locally. It can also be connected directly to terminal peripheral devices... this terminal architecture makes possible coding, buffering, and local processing". Gooch utilized the microprocessor for added computational power in the development of his sixteen-channel music synthesizer.

To direct the investigation of hardware and software appropriate to the development of a micro-music-system, several approaches were considered. The approach of searching for available systems was discarded in favor of first determining minimum, requisite functions necessary to operate the "model system" and "model music lessons".

The power of the language and the processor was considered against the demands of four "typical" graphics music programs (courseware):

1. Music notation lesson with animation
2. Ear-training lesson, requiring sound generation
3. Random-access tape playback lesson
4. Visual color-slide lesson in music pedagogy

The investigation of the available computer (processor) and computer languages were combined for the most part. A processor/language combination capable of presenting the four programs was deemed "acceptable". As a point of comparison, lessons were selected from available PLATO IV music lesson catalog in each of the four areas for quality standards.

Computer language packages in most cases have been developed with a specific processor in mind. Microprocessors of similar capacity normally were found to have similar available operational options. The search for "PLATO-quality" graphics limited the investigation of hardware to sytems that would support graphics terminals. With the available PLATO V hardware as a programmable terminal, initial attention was directed to its courseware development stand-alone operation.

Early attempts at writing music courseware were conducted on a modified PLATO V terminal developed by Carroll Manufacturing Company. The INTEL 8080 microprocessor could be programmed in several modes including assembler language and an experimental version of TUTOR named MICROTUTOR which has been developed by Andersen. An ear-training lesson was developed as a MICROTUTOR lesson and partially as an assembler language lesson. When the first two lessons were written for evaluation, the decision was made to use a very early version of MICROTUTOR.

The experimental lessons, developed for evaluation, could be down-loaded from the PLATO network computer to the terminal and used as terminal-resident lessons. Once the lesson was loaded into the terminal, the system computer could be disconnected during the operation. Later versions of the lessons could be transferred to the Carroll terminal from cassette tape. The loading process was longer than desired, but the process demonstrated the ability to operate an instructional lesson with no interaction from the large PLATO computer.

At this point in the project, hardware and software were found acceptable for the delivery of music lessons which required music peripherals. The version of the computer language was difficult to use as compared to the normal TUTOR used on PLATO. Slight hardware alterations were necessary to operate the terminal when disconnected from the main computer. The major disadvantage was one of lesson length. A drill lesson could be written that would randomize ear-training exercises for an hour; however, if lessons required many written or graphics displays, the lesson time length was much shorter than the forty-five minute length desired. A hardware limitation of approximately 4000 eight-bit words of lesson material could be loaded for instruction. In an interactive mode (on-line), additional lesson material could be loaded quickly as requested by the student. This option was not available in the stand-alone mode of operation.

Four lessons were written to demonstrate the capability of operating the four-voice tone generator, the random-access tape playback system and the random-access microfiche slide viewer, plus the touch panel. Each lesson was a short demonstration which was interactive and instructional. These lessons were completed during the Spring of 1978.

To resolve the limitation of the 4000 word memory, a floppy-disk system was attached to the Carroll terminal to store lesson materials which exceeded the capacity of the terminal. This system was developed by Stifle and Andersen at the University of Illinois and constructed by Regency-Carroll Manufacturing Company.

The floppy-disk system is capable of storing long instructional lessons and transfer information to the terminal in "unit" segments as needed for lesson operation. This system of storage and recrieval was patterned after the PLATO computer "extended-core storage" (ECS), which has information readily available for the processor to call as needed. The access time to call a new unit did not interfere with normal lesson operation.

Music courseware was written for the floppy-disk, stand-alone computer system and was demonstrated for the first time in June, 1978. These materials were developed on PLATO and down-loaded to the floppy-disk for program operation. Once materials were transferred to disk, no further interaction was needed with the host system (PLATO).

COURSEWARE TRANSFER

Although this project resulted in the selection of PLATO-compatable hardware and software, several other microprocessors were found capable of supporting satisfactory music instruction. Surveys by Dennis (1977) and others indicate that BASIC and MINI-BASIC are considered very popular languages for instructional purposes. Several eight-bit processors and new sixteen-bit processors are available to the researcher.

An investigation of the use of microprocessors for instruction in music was expanded to consider such systems. In investigating the popular "home-computer" market, several microcomputers were considered as acceptable for supporting music instruction. The home computer selected for this transfer project, the APPLE II computer, found its way into a growing number of schools elementary through university level.

Since the APPLE II computer was being used experimentally in several areas of instruction, the investigation of the music courseware transfer was expanded. A comparison of the PLATO V music system with the available APPLE II computer system was made to determine the feasibility of transferring music lessons from PLATO V to the APPLE II computer.

A direct transfer of instructional materials was found to be very difficult, due to the difference in screen sizes, the APPLE screen being smaller. Using an APPLE II computer as a PLATO terminal demonstrated that the APPLE computer could be programmed in a similar manner as the PLATO V terminal, to display graphics materials. Although the processor did not allow the use of the MICROTUTOR language, the APPLE computer could be programmed to present instructional materials in several other languages.

A PLATO IV music program was transcribed from the TUTOR language to BASIC language on the APPLE II computer as a comparison of courseware quality. The result was deemed acceptable, although several graphics displays were omitted in the transcription process. This process of essentially rewriting a computer lesson was found to be an arduous one. The result, then, was acceptable but the means of transferring the lesson was laborious.

To resolve this question, a computer program was written on the PLATO computer called a cross-compiler. This computer program allows the author of computer materials to sit at the PLATO terminal and produce courseware, then have the computer transcribe the lesson for the APPLE computer. Although this cross-compiler is an experimental program, this approach of producing materials for microprocessors is seen as a viable, time-efficient means of courseware development and transfer. A well-developed cross-compiler could be used to convert courseware from PLATO to the APPLE and select other microcomputers, enabling the rapid development of the same lesson for three, four or five different home computers.

CONCLUSIONS

The lessons developed for the PLATO V music system were considered satisfactory and equivalent to PLATO IV lessons requiring similar peripheral equipment. The advantage of the terminal-resident lessons was the very rapid display of information on the computer screen. The obvious advantage of single-user operations was evidenced in seemingly instantaneous key-processing.

The findings of this continuing investigation indicate that micro-processors can support high-quality music instruction. The next major step to implementing micro-computer-based instruction is the development of a catalog of materials for use with emerging systems which can be applied to music instruction. Authors of CBE materials must consider the microprocessor as a viable instructional system.

The case of developing micro-lessons on a large computer was noted as significant. The pilot programs developed for this project indicate successful translation of programs written on a large computer mainframe to a microprocessor. From the experimental lesson results, a microprocessor unit has the demonstrated capacity to support high-quality computer-based education in music.

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